mass of information on its more important topics. It is only natural that a work which is essentially a compilation, should be of a somewhat patchwork character; but it is to be regretted that in some of the sections the different paragraphs do not offer more coherent reading. It would further have been an advantage to the general public, whose education in these matters is so essential an element in the further progress of public health, if so many technical terms had not been used without explanation. Occasional looseness of expression is to be noticed. As when we read of "Bacterium termo, the microbe of impure water," or, "the Zeiss system magnifies three to four thousand times." But to those for whom the book is specially written, those interested or officially concerned in the promotion of health, it will prove a valuable work of reference.

THE PHYSIOLOGY OF THE INVERTEBRATA.

The Physiology of the Invertebrata. By A. B. Griffiths, Ph.D., F.R.S. (Edin.), F.C.S. (London: L. Reeve and Co., 1892.)

STUDENTS of biology, and especially of physiology, have long wanted a book treating of the physiological problems of the invertebrate animals. It is true that what is sometimes called human physiology is in great measure the physiology of the lower animals. Physiologists, however, generally select for experiment animals which are as much as possible like themselves; it is comparatively seldom that they invade the invertebrate branches of animal life. There are vast fields there for exploration which are almost untouched from the physiological standpoint, and one can hardly doubt that great treasures in the way of fact and reasoning could be unearthed, which would throw light on the functions not only of these lower creatures themselves, but on the life problems of the higher animals also. The present book by Dr. Griffiths will therefore be welcomed as a first attempt to fill this gap. He is well known as one of the few who have carried the method of physiology down to the invertebrates, and his researches have been marked by great industry and patience.

In treating of invertebrate physiology, it is obvious that there are two courses open to a descriptive writer: one is to take the various sub-kingdoms as the main headings, and to treat of the different functions of each before proceeding to the next; the other method is to head the chapters with the functions—circulation, respiration, and the like—and to describe each of these in the various branches of the invertebrata. No doubt there is much to be said for each course. The latter, which is the one adopted in the present volume, appears, however, to have these disadvantages, that it involves a good deal of repetition, and that each chapter is split up into a number of small paragraphs, and there is thus but little continuous narrative. This is increased by the habit the author has of making extensive quotations, so that there is little uniformity of style; half a page will be given in the flowing style of Huxley, and the next half in the less fluent English of other writers. It appears to us it would have been better if Dr. Griffiths had given the results of other investigators in his own language. This, however, is a minor point. Passing to more important matters, we may proceed to enquire if the book really meets the want which has been stated to exist; and the answer to such an enquiry must depend on whether the good in it outweighs the bad, or the reverse. The features in the book which appear to be excellent, are, first, the evidence that a vast amount of pains has been expended in its compilation; and on those subjects to which the author has devoted research-work—the excretions, the blood gases and salts, and digestion—he is distinctly good, and men of science will be glad to have all Dr. Griffiths' experimental work in a handy form, instead of having to hunt it out from journals. Then the whole is exceedingly interesting, and will no doubt stimulate others to prosecute new work on the subject.

There is, however, much that must come in for adverse criticism, and the first point to which attention may be called is not so much the fault as the misfortune of the author in having to deal with a portion of biological science which is in an embryonic condition. Where little is known little can be said, and some of the chapters are little more than anatomy, with physiological excerpts from anatomical works. Again, on certain subjects such as muscular contraction and blood coagulation, the author is evidently not acquainted with the literature of his subject, and in other cases again there is internal evidence to show that Dr. Griffiths has not consulted original memoirs, but abstracts of them that have appeared elsewhere.

The main objection, however, that physiologists will feel about the work, is the conclusion to which they can hardly help coming, that Dr. Griffiths has not the advantage of being a physiologist; there is no wide grasp of the facts and hypotheses with which he has to deal, and the hand of the amateur is continually to be seen. Take as an instance the following sentences: "Urea is a product of *more or less* complete oxidation of *organic substances*, and is *formed in muscular tissues* by the *disintegration of the anatomical elements*. Uric acid on the other hand is the result of an incomplete oxidation, and is produced for the most part *in the blood*, or its equivalent when such fluid is *surcharged with peptones* which the tissues are unable to assimilate." (The italics are our own.) Again, in the chapter on the physiology of the sense organs, the difference between the tactile sense and general sensibility has not been apparently grasped; and even on subjects which the author has himself investigated, very often elementary facts have escaped him. Thus it appears that uric acid is the most constant of the nitrogenous metabolites in the invertebrata, but we are not in the majority of instances told how this insoluble substance is held in solution in an aqueous liquid. We also read that after starch has been digested with the secretion of the hepato-pancreas, it gives a precipitate of cuprous oxide with Trommer's test, and this is regarded as sufficient evidence of the formation of glucose. No reference is made to the fact that anylolytic ferments in the vertebrata produce maltose and not glucose from starch. Again, one would judge from Dr. Griffiths' words, that he regards the formation of leucine and tyrosine as the chief functions of a proteolytic ferment, or from the omission of hæmocyanin from the chapter on respiration that it was not a respiratory pig-

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ment, though this would be corrected by reference to the chapter on the blood.

Taking a general survey of the whole, we see that the book is far from perfect. Few books are when they first appear, and much that is faulty can be corrected in subsequent editions. We must, however, congratulate Dr. Griffiths on being the first to break new ground by producing a work on the subject, as well as on the good points that the book exhibits, and to which allusion has already been made.

W. D. H.

THE DESIGN OF RETAINING WALLS AND RESERVOIR DAMS.

A Text-Book on Retaining Walls and Masonry Dams. By Prof. Mansfield Merriman. (New York: John Wiley and Sons, 1892.)

BEFORE entering upon the investigation of retaining walls and their design, the author devotes two chapters to the consideration of earthwork slopes and the lateral pressure of earth. Owing to the changeable condition of earth under the influence of moisture, and the variable nature of any stratum, it is impossible to obtain strictly exact expressions for the forms of slopes of cuttings and embankments, or definitely accurate values for the lateral pressure of earth; but, nevertheless, the formulæ deduced by the author from general principles are useful in serving as a guide to correctness of design. It is indicated that theoretically an earthwork slope should be curved, becoming flatter towards the base; and though a straight slope is always adopted for cuttings and embankments, the curved form left by slips is somewhat in accord with this theory. The inclination of slopes must indeed depend on the nature of the soil, and must be flatter in made ground than in cuttings; whilst efficient drainage and protection of the surface of the slopes from the weather are equally important for ensuring stability.

The pressure of earth is the basis of all theoretical principles relating to retaining walls, and it has formed the subject of numerous experimental investigations in England and on the Continent which might have been advantageously referred to in this book. The author adopts the view that the pressure is normal to the back of the wall; but as this theory is not universally accepted, he has also obtained a formula for inclined pressure. A retaining wall may fail by sliding or rotation, and the masonry is assumed to be laid dry, owing to the uncertain amount of cohesion in mortar joints. In practice, however, retaining walls of any height are built with cement mortar; and sliding occurs at the base, or even sometimes on detached slippery surfaces of clay below the base; whilst rotation is due to excessive pressure on yielding foundations at the front of the wall. Stability largely depends upon the nature of the foundation and the backing behind the wall. A clay foundation is far less trustworthy than gravel, and sliding is most effectually prevented in slippery soils by carrying down the foundations well below the surface; whilst careless backing up with bad materials, not brought up in their layers, may push over the wall. Efficient drainage, moreover, at the back of the wall, and outlets for water at intervals through the wall to prevent its accumulation behind, are almost as important considerations as the design of the wall. A wall leaning over backwards is shown to be the most economical; but though this form might be adopted for building against an embankment, it would not be convenient for a wall built in a timbered trench to retain the side of a cutting. The four chapters relating to earthwork and retaining walls, which comprise the main portion of the book, will be very useful for practical engineers who desire to extend their theoretical knowledge on these subjects; but students should bear in mind that an almost exclusive treatment of the theoretical aspect of these questions must be supplemented in actual design by practical experience.

The theory of the strains on masonry dams, considered in the concluding chapter, is more precise, owing to the exactness of our knowledge of the laws of water pressure as compared with the uncertain and variable pressure of earth. The well-known condition of stability, that the lines of resultant pressures, with the reservoir empty and full, should fall within the middle third of the cross section, is explained, as well as the uncertainty which exists as to the actual distribution of the pressures throughout the dam. The lines of resultant pressures for any given section are easily obtained graphically, for the line of pressure with the reservoir empty is the locus of the centres of gravity of the sections above a series of base lines taken down the dam, and the actual pressure is the weight of these successive sections; whilst the line of pressure with the reservoir full is the modification produced in the former line by the addition of the water pressure at the successive depths. The theoretical section given on page 110 resembles the section of the Furens dam in France, the highest masonry dam hitherto erected, the form of which was determined by elaborate analytical calculations. The principles laid down concerning masonry dams require to be supplemented by two practical considerations, namely, that high masonry dams must be founded on solid rock to secure them against undermining and settlement, which would be fatal to their stability; and that their inner face should be coated with an inpervious material, to prevent the infiltration which otherwise takes place through their joints at great depths. In taking the pressure due to waves on the top three or four feet of the dam below the water as equivalent to the greatest observed pressure exerted by waves on the sea-coast, the author far exceeds the probable limit; for ocean waves, owing to the great extent of the exposure and the depth, are impelled with a much greater force than the waves of a comparatively small and sheltered reservoir. The additional strength given to a dam by arching it towards the reservoir is very properly neglected in the calculation of its stability, for besides being difficult to estimate precisely, this increase in strength is inappreciable in a long dam, and even in the short Furens dam the arched form was merely regarded as an extra safeguard.

The book is clearly and concisely written; it is illustrated by numerous diagrams in the text; and problems to be worked out are given at the end of most of the articles, each of which deals with a subject under a special heading.

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